



TITLE:

楽友 = Raku-yu : Kyoto University newsletter, Issue 15

AUTHOR(S):

Public Information Division, Kyoto University

CITATION:

Public Information Division, Kyoto University. 楽友 = Raku-yu : Kyoto University
newsletter, Issue 15. 楽友 2009, 15

ISSUE DATE:

2009

URL:

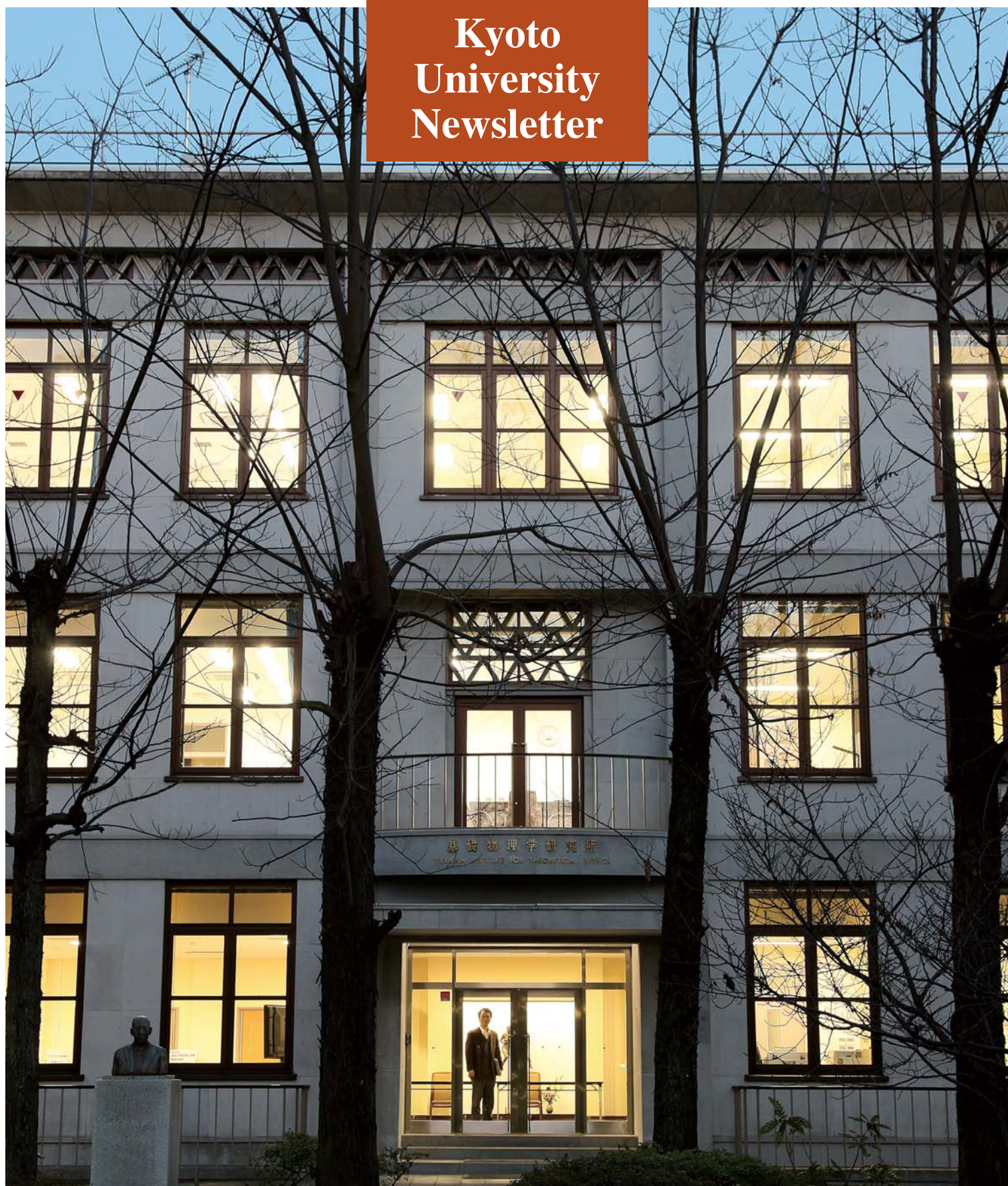
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楽友
Raku-Yu

Kyoto
University
Newsletter



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Welcome to the 2009 Spring issue of *Raku-Yu*. In each issue we attempt to present a wide view of the current academic and cultural activities of Kyoto University to inform you, the international reader, about what the university has to offer. In this issue we are happy to feature a special interview with one of the three joint recipients of the 2008 Nobel Prize in Physics, Kyoto University's Professor Emeritus Toshihide Maskawa. Dr. Maskawa shared this prize with Dr. Makoto Kobayashi and Dr. Yoichiro Nambu for their work on Spontaneous symmetry breaking. "CP Violation in the Renormalizable Theory of Weak Interaction" written with Dr. Maskawa and Dr. Kobayashi is the third most cited high energy physics paper of all time as of 2006.

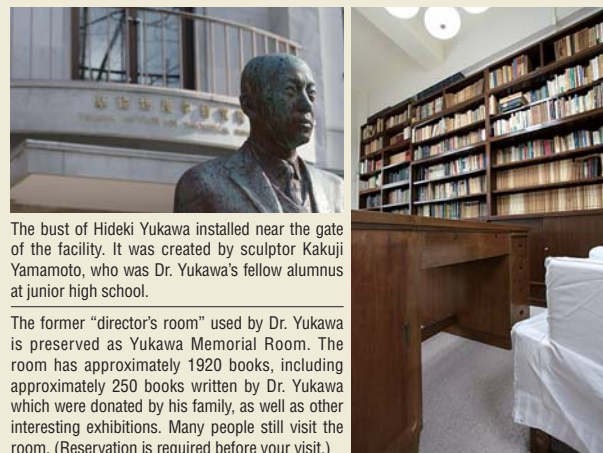
The university's GCOE program (see Special Feature starting on page 6), is a new project which aims to train a new generation of scientists to excel in the international arena. The university is undergoing a new phase of internationalization in education and research, reaching out to provide first class education and training to young scientists from around the world. This issue presents a number of projects within GCOE and explains their roles in this internationalization process. Kyoto University is not one to sit on its laurels. Academic internationalization and projects like the GCOE are one means to pursue excellence. Perhaps international collaborations germinated between young researchers at Kyoto University involved in the GCOE program will produce future Nobel Laureates.

Front Picture: Yukawa Institute for Theoretical Physics

In 1949 Dr. Hideki Yukawa became the first Japanese citizen to be awarded the Nobel Prize in Physics. At that time, he was a professor of Kyoto University and was living in the United States as a visiting professor at Columbia University. In commemoration of his achievement, Risaburo Torigai, then Kyoto University President, proposed the establishment of the Yukawa Hall, a memorial hall which would serve as a center for the advancement of science. With support from the Science Council of Japan, the proposal was implemented, and the construction of the hall was completed in 1952.

At first, the Yukawa Hall was the university's facility. However, in response to a request from theoretical physics researchers throughout Japan, it was relaunched in 1953 as the Research Institute for Fundamental Physics, and was the first national research institute to be used as a common research hub for researchers across the nation. The research institute has adopted a unique system of administration: while it belongs to Kyoto University, its administration policies are decided by a steering committee which consists of both institute members as well as non-member representatives elected from throughout Japan, with non-member representatives accounting for the majority of the committee members.

The institute provides opportunities for research collaboration and discussion, which enable researchers from Japan and overseas to contribute to the advancement of theoretical physics.



The bust of Hideki Yukawa installed near the gate of the facility. It was created by sculptor Kakuji Yamamoto, who was Dr. Yukawa's fellow alumnus at junior high school.

The former "director's room" used by Dr. Yukawa is preserved as Yukawa Memorial Room. The room has approximately 1920 books, including approximately 250 books written by Dr. Yukawa which were donated by his family, as well as other interesting exhibitions. Many people still visit the room. (Reservation is required before your visit.)

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KOSOSHA CO.,LTD.

Printed by

KOSAIDO CO.,LTD.

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A Note on Order of Names

As a general rule, names appearing in *Raku-Yu* are written in given name/family name order.



This name was taken from the assembly hall called "*Raku-Yu Kaikan*" that commemorated the 25th anniversary of the founding of Kyoto University.

Hiroshi MATSUMOTO Born in 1942, he graduated from the master's course in the Graduate School of Engineering in 1967 and continued on to earn an Engineering doctoral degree in 1973 both from Kyoto University. He became an associate professor of the Faculty of Engineering at the university in 1974, and from the following year, worked as a visiting researcher at many institutions such as NASA Ames Research Center and Stanford University. He became a professor at Kyoto University's Radio Atmospheric Science Center in 1987, and the director of the center in 1992. After his experience as the director of the Research Institute for Sustainable Humanosphere, he became an executive vice-president in October 2005. He has been striving to improve the working environment for researchers. In order to win competitive funds such as scientific research funding, he established an office to help researchers with such practical procedures as arranging applications and collecting information. This has been successful in bringing fruitful results. He has also been highly praised for establishing the Center for Women Researchers and Start-up Research Funds for Young Researchers, earlier than any other institutions. Among his achievements is the Intramural Loan Program, which provides the necessary funds required to maintain the most advanced level of research which has been gaining attention as a unique program only found at Kyoto University. Furthermore, he recognizes the importance of such basic studies as Humanities and Social Sciences in maintaining the character and culture of the university, and has secured a new budget for these studies called "University Cooperative Expenses". In October 2008, he was elected as the 25th president of Kyoto University. On assuming the post, President Matsumoto said emphatically, "I intend to dedicate myself completely to meeting the challenges and responsibilities of this position."



Aiming to instill Kyoto University with attractivity, vitality and capability

Since it was founded in 1897, Kyoto University has emphasized an academic style characterized by academic freedom and frank dialogue. Located in Kyoto, the university advances its higher education and cutting-edge academic research while fostering a spirit of self-reliance among its students and researchers. In this current period of great upheaval for universities, more than ever before, there are high expectations for Kyoto University to maintain its heritage of academic freedom while resolutely tackling the world's many problems and contributing to a harmonious global community in its characteristic manner.

The primary mission of universities is the cultivation of human resources through the "dissemination of knowledge." Research, the second mission, entails that universities undertake cutting-edge research activities whilst being engaged in a profound search for truth in order to "foster knowledge" and "construct an intellectual system." Additionally, the creative research activities of universities must include an element of human resource development through the involvement of their students. In this way, the education and research activities of a university are like the two sides of one coin, and a balance must be kept between the two. The third mission, contribution to society, may take many diverse forms, such as the transmission of knowledge to society, industry-government-academia collaboration, policy recommendation, or the provision of

high-level treatment by university-affiliated hospitals.

In meeting these diverse requirements, Kyoto University must emphasize its unique qualities as an academic center based in the prestigious and culturally rich city of Kyoto, and demonstrate, domestically and internationally, its robust strategy to consistently produce cultured global citizens and world-class researchers. It is my intention to perform my duty as president with a resolute and dignified spirit, unswayed by passing trends and fads.

Education and research are the foundations of any university. In order to ensure the excellence of that foundation, faculty and staff must be able to take pride in their work, a high caliber of students must be fostered, and the system itself must be sustainable.

I intend to reform the system, structure and approach of Kyoto University in a way that will enable our faculty and staff to demonstrate their true abilities. Through doing so, I believe that the university will be instilled with attractivity, vitality and capability, and will be capable of fulfilling all of the missions discussed above.

松本 紘

Hiroshi Matsumoto
President of Kyoto University

Dr. Maskawa talk about his early prize winning research

In the autumn of 2008, two physicists who spent their early lives as researchers at Kyoto University received the Nobel Prize in Physics. They are Dr. Toshihide Maskawa (Professor Emeritus at Kyoto University) and Dr. Makoto Kobayashi (Professor Emeritus at the High Energy Accelerator Research Organization).

Their 'Kobayashi-Maskawa Theory', which earned them the award, was published in 1973. They formulated their idea while the two working together at the Department of Physics, Kyoto University.

Commemorating that honor, we had an opportunity to have an interview with Dr. Maskawa and Prof. Taichi Kugo, the former director of the Yukawa Institute for Theoretical Physics. (The interviewer is our chief editor, Mitsuhiro Shishikura, professor of the Graduate School of Science)

Mitsuhiro Shishikura: *Dr. Maskawa, Congratulations on receiving the Nobel Prize in Physics. Could you explain your work with Dr. Kobayashi which earned the prize?*

Toshihide Maskawa: As you know, matter in our world consists of atoms. An atom consists of a nucleus and electrons, and the physical laws which govern them were revealed by Heisenberg and Schrödinger by 1926. Further research revealed that a nucleus consists of protons and neutrons. Around 1955, via cosmic rays, new particles were found one after another. Then Prof. Shoichi Sakata at Nagoya University put forward a model, the Sakata model, in which three of 20 or so elementary particles which had been discovered were fundamental particles, with all the rest being made up from combinations of those three. Later this model was developed into the quark model of Gell-Mann and Zweig. At the same time the dynamics of those particles were studied. The biggest discovery, by Lee and Yang in 1955, was that the law of physics is not symmetric as in mirror symmetry (replacing left and right). It was then proposed that the law should be symmetric when you interchange particles with and anti-particles at the same time as you interchange left and right. This is called CP symmetry. Later on, it was experimentally discovered by Fitch and Cronin that CP symmetry is also broken, although at a much weaker level than mirror symmetry. When this discovery was published, I was in the second year of my master course and had just joined Prof. Sakata's lab. In the lab, we had 'journal club' whereby we

took turns reading recent articles from journals and presenting them to the rest of the lab. When it came to my first turn to do the journal reading, there was the article about the discovery of the violation of CP symmetry, by Fitch and Cronin.

Taichi Kugo: Was that the first report of CP symmetry violation?

TM: Yes, it was.

TK: Since your lab mates took turns reading the journals, do you think it could have been someone else who noticed the article?

TM: Yes, it was simply a stroke of fate.

TK: When the results of the experiment on CP symmetry violation came out, were there a lot of physicists trying to explain it?

TM: No. No, there weren't.

MS: *How did you come to have the idea of constructing a theory to explain the CP symmetry violation?*

TM: Ever since I knew about the Fitch and Cronin article, I'd felt like there was something stuck in my throat. Then in 1971, 't Hooft and Veltman showed that weak interaction was a renormalizable theory. At that stage, I thought that with that theory it might be possible to explain CP symmetry violation. Likewise, Dr. Kobayashi, who was at Nagoya University at the time, was interested in CP symmetry violation. And so when he moved to Kyoto University in 1972, I suggested to him that we might work together.

MS: *And did you divide the work up between the two of you?*

TM: Kobayashi can do just about anything, whereas I'm no good at the experimental side. And so I proposed number of models

■Profile

Toshihide MASKAWA

- Born in 1940
- 1962 Graduated from Faculty of Science, Nagoya University
- 1967 Completed doctoral program, Graduate School of Science, Nagoya University,
- 1967 D.Sc., Nagoya University
- 1970–1976 Assistant Professor, Faculty of Science, Kyoto University
- 1980–1990 Professor, Yukawa Institute for Theoretical Physics
- 1990–1997 Professor, Faculty (and Graduate School) of Science, Kyoto University
- 1997–2003 Director, Yukawa Institute for Theoretical Physics
- 2003– Professor Emeritus, Kyoto University

Guests



Dr. Toshihide MASKAWA



Prof. Taichi KUGO

which could possibly bring about CP symmetry violation, and Kobayashi would think about whether it would be compatible with already known various experimental facts.

MS: *It's been said that the idea behind the Kobayashi-Maskawa Theory came to you while you were in the bath...*

TM: It was just not possible to solve the CP symmetry violation problem with the 4 flavor model, and there was one time when I

made the right-handed current model, but the next day Kobayashi cautioned me that that wouldn't work either. When I got home and took a long hot bath, and started to think if there was any way to breathe new life into this. But however I looked at it, the 4 flavor model was a non starter. It's embarrassing to admit, but I thought there was nothing else but to write it up in a paper as an example of a theory which had failed. When I got up out of

About the Kobayashi-Maskawa theory



The work which has earned Dr. Kobayashi and Dr. Maskawa their Nobel award was carried out during the time they were both working as assistant professors of the Theoretical Particle

Physics Group (former Yukawa Laboratory) in the Department of Physics, Kyoto University.

The theory expounded by Dr. Kobayashi and Dr. Maskawa, proposes an explanation of why and how the symmetry between particles and antiparticles in the natural world, called CP symmetry (charge parity symmetry), is broken. It has become the framework for the Standard Theory of elementary particles today.

At the time of the creation of the universe by the Big Bang, the particles and antiparticles were created in pairs, and so existed in precisely the same numbers. If there was CP symmetry, then the other side of the coin would be that as the universe cooled down, all matter would disappear through pair annihilation, and the world that we have today would never have existed. The fact that the material world does exist today is due to the CP symmetry being not perfect, but rather, very slightly broken. This tiny violation in CP symmetry was also discovered in 1964 in a terrestrial experiment of elementary particles.

Dr. Kobayashi and Dr. Maskawa took up the question as to whether this loss of symmetry could be explained in the framework of the unified field theory of weak and electromagnetic interactions, which was new at the time in 1972.

In the present theory of elementary particles,

quarks and leptons are the fundamental particles of the natural world. There are more than a few hundred different types of so-called 'strongly interacting particles' such as the proton and the neutron, which make up the nucleus of an atom, and also the pions which Dr. Hideki Yukawa had predicted. These particles are in fact not really 'elementary' particles, but are composite states made up from quarks, fundamental particles one layer further down. Particles such as electrons and their partner neutrinos are known as leptons which don't participate in the strong interactions.

At the time, the weak-electromagnetic unified gauge theory was still only just proposed as a theory for leptons such as electrons and neutrinos, and did not include quarks which interacted strongly. The Kobayashi-Maskawa theory first of all clarifies how the quark can be included, and then goes on to devise a new mechanism to explain the violation in CP symmetry. For this mechanism to work, it predicted that there must be at least 6 kinds of quark, not just the 3 kinds which were known about at the time.

In subsequent experiments the new quarks were discovered, one after another, and with the discovery of the top quark in 1995, all six types had been confirmed. Also, by the Belle experiment at the High Energy Accelerator Research Organization at Tsukuba, and the BaBar experiment at the Stanford Linear Accelerator Center, using the B meson, precise measurements were taken which confirmed, by around 2001, that the CP symmetry violation can be explained in accordance with the Kobayashi-Maskawa mechanism.



CP symmetry violation simply could not be explained within the bounds of what was known at the time. Accordingly, there had to be something else which was still unknown, which we firmly believed could be proven by the Kobayashi-Maskawa theory. From that starting point, we asked what the possibilities were, and we came up with a 6 flavor model, but at the time there was no logical basis for it. It was merely one of the possibilities, and we had no conviction that this model was the correct one.

**Dr. Makoto
KOBAYASHI**

(This interview originally appeared in the Kyoto University Newsletter.)

Prof. Taichi KUGO



the bath, the 6 flavor model came to me. Just as I was thinking of writing it up as a failed theory, the major premise that I'd been obsessed with, namely that there should be 4 flavors in the model, just disappeared. And so the next day, I proposed to Kobayashi that we should write a theory based on a 6 flavor model. Kobayashi agreed on the spot, not even wanting to think about it overnight. That was at the end of June, and September 1st we submitted it to the *Progress of Theoretical Physics*, published by the Yukawa Institute for Theoretical Physics at Kyoto University and the Physical Society of Japan. It came out in the March edition of the following year, 1973.

TK: The Yukawa Institute for Theoretical Physics is a focal point for research in elementary particle theory, not just in this country but internationally as well. So while the research institute certainly is a part of Kyoto University, it goes beyond the university's boundaries. In that sense, did you have any special feelings in 1970 when you were about to come up to Kyoto?

TM: Indeed, Kyoto University was very advanced in field theory, and so looking at it from Nagoya, I was filled with anticipation for the future.

TK: I entered the Physics Department of Kyoto University in 1971, but I don't necessarily remember it as feeling like a center for field theory at that time. It was more the case that Dr. Maskawa brought field theory to the Physics Department at Kyoto University. Dr. Maskawa first introduced Weinberg's paper 'A Model of Lepton' in our laboratory in December of 1971. Field theory was not fully accepted at that time anywhere in the world, since it is more or less ineffective with regard to strong interaction, and so this was a very fresh story. The very existence of quarks was still only half believed by people, so it was actually just Dr. Maskawa's sense which led him to think that this theory could open up an important new direction in the future.

MS: *Have you been fond of arithmetic and science ever since you were little?*

TM: Every day when I was at primary school, I used to play until late in the evening. I didn't used to study much, so one day my

mother apparently told the teacher, "Our son doesn't do any studying at all, so would you please give him some homework?" And then the teacher said, "But I do give out homework every day. Your son doesn't do it." (laughs) What got me started on studying was when I discovered books. As a boy at primary school, there was something I had to find out about, and so I went to the local library and opened up a book, I can't remember now, what book it was, but I do remember feeling terribly excited for some reason. Ever since then my world has revolved around books.

MS: *What made you go into the world of physics?*

TM: When I was in senior high school in Nagoya, I read in a local newspaper that Prof. Sakata had done some outstanding world class research in particle physics and thought simply, "I want to work in that field", and set my sights on Nagoya University. I can say that Prof. Sakata motivated me the most at that time. But our family ran a business dealing with sugar for confectionary, and there was a serious shortage of labor at the time, and so my father was counting on me to help out with the business. And so I promised him that I would only sit university entrance exams one time.

TK: And if you'd failed, you would have gone into the family business.

TM: That was the only time in my whole life, you know, up to this point, that I'd really put all my effort into studying.

TK: Did you aim to be a physicist right from entering university?

TM: The first university researcher I ever saw was a terrific professor called Fujio Nakano, who was in his early 30s at the time. Whenever we went to ask him a question, we would be told to go and find out the answer for ourselves. Rather than spoon feed his students, he taught us how to plug away at finding things out, and so become researchers by collecting information by ourselves. From that time I became to greatly admire researchers. I was interested in all sorts of fields besides physics, and I even studied about the brain with my fellow students for about three months. If I'd gone into the Medical School, I might have become a cerebral physiologist, you know. (laughs) Even now, I'm interested in evolution. But anyway, I didn't take it that far, and ended up eventually in Prof. Sakata's



lab. That was the second year of my master course.

MS: *I heard that you often think about things while you're walking around...*

TM: I can't think if I don't walk about. As soon as I sit down in front of a desk my thought processes stop. (laughs) It's the same if there's anyone next to me. So, anyway, I walk about, mainly.

TK: I heard something about you almost having had a traffic accident...

TM: I always speaks to my wife that if I ever had a traffic accident, it would be my fault. (laughs) No, joking apart, I got yelled by truck drivers three times. They said, "Which way are you walking? You've got a red light, you know!"

MS: *Don't you find Kyoto a good city to walk around in while you're doing your thinking?*

TM: In winter the *Philosopher's Path* is good. It's interesting to see the Kitashirakawa canal crossing above a natural river at one point. I love to talk about these things. (laughs)



MS: *Finally, do you have any message for those from abroad or in Japan who are going to study at Kyoto University?*

TM: When you're doing research, you quite often have to do things which are off your main theme, things which you may be averse to. But it's important to set your target as high as possible and not to lose sight of your goal even when things do get tough. Always keep at it, plug away at your experiments or whatever hands-on stuff you're doing everyday. It is also important to exchange ideas freely with your friends and seniors.

Student Forum Held to Commemorate the Awarding of the 2008 Nobel Prize in Physics to Professor Emeritus Toshihide Maskawa

A forum for Kyoto University students was held to commemorate the awarding of the 2008 Nobel Prize in Physics to Kyoto University Dr. Toshihide Maskawa, on October 8, the day after the announcement of prize recipients. Although the event was held without much prior notice, the 300-seat hall in the Faculty of Science Building No.6 was filled to capacity, with many participants having to stand, and many more unable to enter the auditorium. The ginkgo tree-lined pathway leading to the faculty building was lined with students, who greeted Dr. Maskawa's arrival with applause and cheers of congratulations.

During the forum, Dr. Maskawa spoke about his student days, and advised the students, "You don't have to speak a foreign language to be a researcher, but it will be vital in the coming era of internationalization, so please be sure to study foreign languages."

Drawing on his own personal experiences of studying at high school and university in response to the students' questions, Dr. Maskawa's responses often entertained as well as informed his audience. His humor occasionally filling the auditorium with laughter. Other topics, however, were treated with great gravity, such as Dr. Maskawa's continuing passion for his field of specialization, and his interaction and disputes with his peers. The professor's good nature and warm character was also revealed as the discussion digressed into topics such as social and personal relationships.

During the forum a congratulatory video message was delivered from the president of Kyoto University, Dr. Hiroshi

Matsumoto, who was on a trip to London at the time.

The students showed their gratitude to Dr. Maskawa for being so generous with his time, despite his undoubtedly busy schedule. The closing of the forum was met with thundering applause, and the professor was presented with a bouquet of flowers.



Center for Frontier Medicine

Medical science is rapidly merging with basic biology today. As symbolized in the human genome projects, our knowledge on genes and their products (building blocks of our bodies) is rapidly expanding, giving us the hope that many human diseases can eventually be explained in molecular terms and their treatments rationally designed. We still have much to learn, however, about the basic principles of how molecular circuitries are assembled, operated, and organized in our bodies. Such knowledge can be obtained not only in experiments in test tubes or in model animals but also by careful examination of human diseases. It is therefore important to enhance bi-directional exchange of knowledge between basic and clinical researchers to obtain important insights into how our bodies work, how diseases arise, and how we can detect and control them.

Such a perspective was our motive for establishing the Global COE program “Center for Frontier Medicine (CFM)” supported by JSPS*. The aim of CFM is to establish a research center in which many talented researchers, both basic and clinical, combine their efforts to generate a research and educational environment

ideal for fostering future global leaders in the fields of medical science.

CFM members are grouped into five “Units”: (1) Allergy and Immunology, (2) Cancer, (3) Aging and Lifestyle-related Diseases, (4) Neuroscience, and (5) Regenerative Medicine. Core Members of each Unit (5 professors) are responsible for evaluating fellowship applicants and steering activities of that Unit. Fellowships include Research Assistantships (RA, graduate students), Pre-doctoral Fellowships (PrD, post-graduate school level), and Post-doctoral Fellowships (PD). Awardees of these fellowships (“Fellows”), have opportunities to know each other and to have advice from multiple senior members through various events, including monthly course meetings and annual course retreats. The Travel Awards provide opportunities for graduate students to attend international meetings overseas and present and discuss their findings in English. The International Internships help young researchers learn innovative techniques in foreign laboratories and boost their studies. We plan to enforce our interreaction with several of the world’s leading institutions, including the



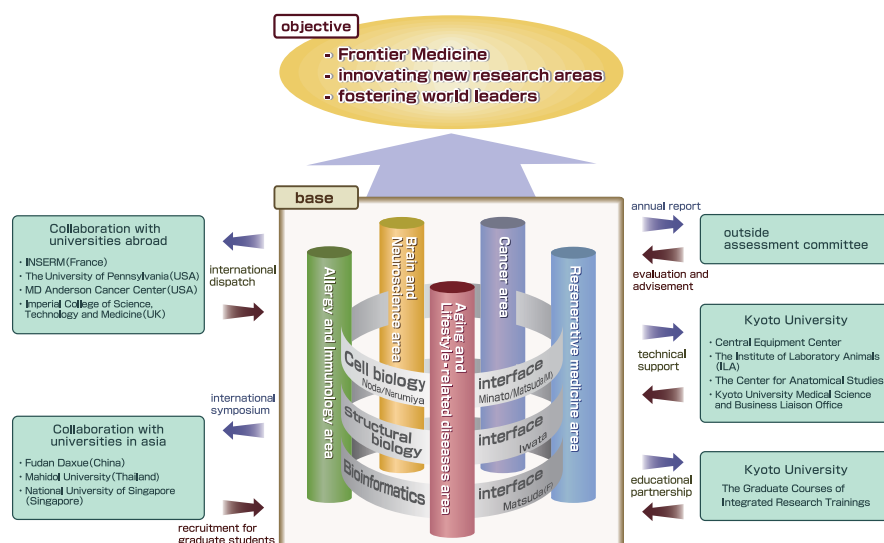
Program Leader:
Prof. Shuh NARUMIYA

University of Pennsylvania (USA), MD Anderson Cancer Center (USA), Imperial College, London (UK), and INSERM (France), and also to establish new partnerships with other institutions.

CFM organizes several Inter-Unit activities. Annual Retreats are the largest events where all core members and Fellows meet and discuss topics of wider perspectives. CFM co-organizes international symposia with several top Universities in Asia. One was held on October 9-11, 2008 in Shanghai. CFM also sponsors a number of seminars on campus, including the Interface Seminar series, featuring topics of broader interest, such as Structural Biology and Bioinformatics, to up-date our knowledge and to stimulate collaborations.

Overall, CFM members have many opportunities to interact with world’s leading scientists, to discuss and collaborate with researchers in different fields, and to share the excitement of discovery and innovation with others, which we believe are the essential elements of training provocative medical scientists.

*JSPS: Japan Society for the Promotion of Science



The Global Center for Education and Research on Human Security Engineering for Asian Megacities



Figure 1. Logo mark of our program

Since 2008, the Global Engineering and Architectural Engineering groups of Kyoto University Graduate School of Engineering, together with the Graduate School of Global Environmental Studies and the Disaster Prevention Research Institute, have been running a Global Center of Excellence (GCOE) Program with 'A Global Center for Education and Research on Human Security Engineering for Asian Megacities' as its theme. GCOE is a program run by the Japanese Ministry of Education, Culture, Sports, Science and Technology, which aims to 'strengthen and enhance the education and research functions of graduate schools, and to establish education and research centers that perform at the apex of global excellence, so as to foster highly creative human resources who will go on to become world leaders in their respective fields. This is done by allowing them to experience and conduct research of the highest world standard.'

Basic human needs, environmental pollution, disasters and how to secure the

capacity to deal with all of these in a self-reliant way, have become major questions in the megacities of Asia, and yet the reforms of the last 10 years have been a catalog of failures. One reason is of course that those cities have expanded dramatically, but more importantly, the maintenance of technology and systems for dealing with the risks involved has been carried out in a piecemeal fashion. Even where further technology and systems have been introduced, there has been a lack of interest in providing personnel or communities to manage them.

Based on a recognition of this, our program is founded on civil engineering, architectural engineering, environmental engineering, and disaster prevention studies, but with a thoroughly hands-on approach. By concentrating our efforts on promoting the complementary co-evolution of engineering technology, urban administrative management, and systems creation, we are transforming the elemental body of learning accumulated up to now, into a more comprehensive body of learning which includes the formulation of policies and management strategies for cities so that they can ensure human security. That is the basis for the education and research which we are carrying out.

In concrete terms, in addition to our



Program Leader:
Prof. Yuzuru MATSUOKA

headquarters in Kyoto, we have developed centers in six cities in parts of Asia (Shenzhen in China, Hanoi in Vietnam, Bangkok in Thailand, Singapore, Bandung in Indonesia and Mumbai in India) which act as overseas bases. We carry out joint research with universities, research institutes and private enterprise in these countries, and train 20 doctoral students a year, among our other activities.

The diagram below gives an outline of our program. Enquiries from interested parties are warmly welcome.

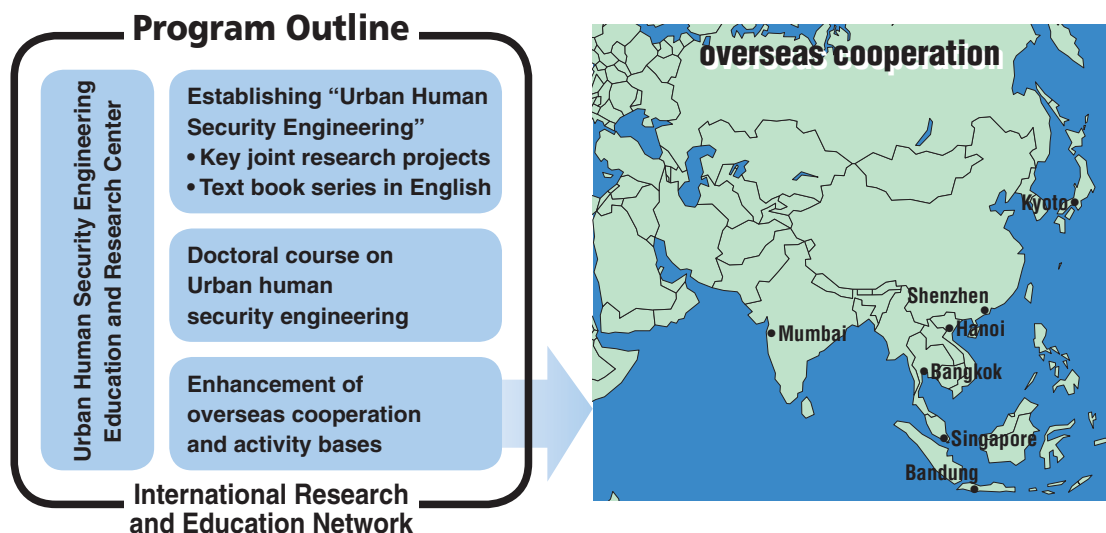


Figure 2. Outline of our program

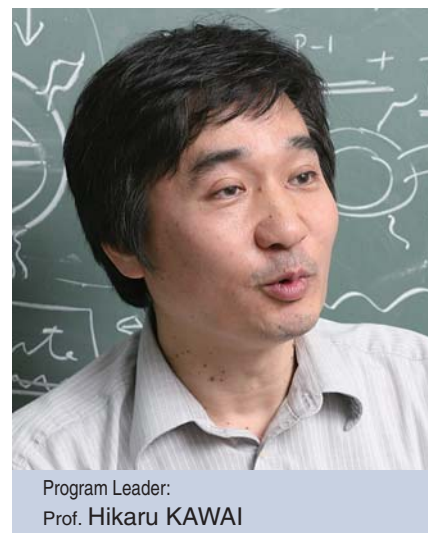
Interplay of Universality and Emergence

Nature consists of myriad scales of structure, from the tiny scales of elementary particles to the vast scale of the universe. Our attempt to elucidate the great variety of phenomena exhibited over this complete range of scales is a pursuit of diversity, while our attempt to construct general laws that can describe such diversity and, indeed, our quest to discover the fundamental law governing nature on all scales is a pursuit of universality. Of course, these pursuits are interdependent, with advances in one leading naturally to advances in the other. In this way, mankind obtains an ever-deeper understanding of nature.

Together with diversity and universality, another key concept in science is that of emergence. Emergence can be understood as the appearance of phenomena whose existence could not have been predicted only on the basis of knowledge of the laws governing smaller scales. Clearly, our recognition of the great variety of phenomena in nature led to the concept of emergence, but this concept goes beyond the mere recognition of nature's variety and can be regarded as a principle according to which we can account for this variety. In order to grasp the significance of emergence and its role in

science, it should first be noted that any phenomena, no matter how complex, must be generated by interactions on smaller scales, and hence, in principle, it should be possible to describe them in terms of more fundamental laws. However, it is essential to realize that nature displays almost limitless varieties of phenomena whose existence could not be predicted even if the fundamental laws governing the more microscopic scales of a system are known. In the study of science, it is often the case that after such a phenomenon has been discovered, it is eventually explained in terms of more fundamental laws, but historically, it is quite rare that truly novel phenomena are predicted purely through deduction from fundamental laws. With this realization, we are led to a scientific viewpoint according to which the infinite variety of phenomena is understood as "emerging" in nature.

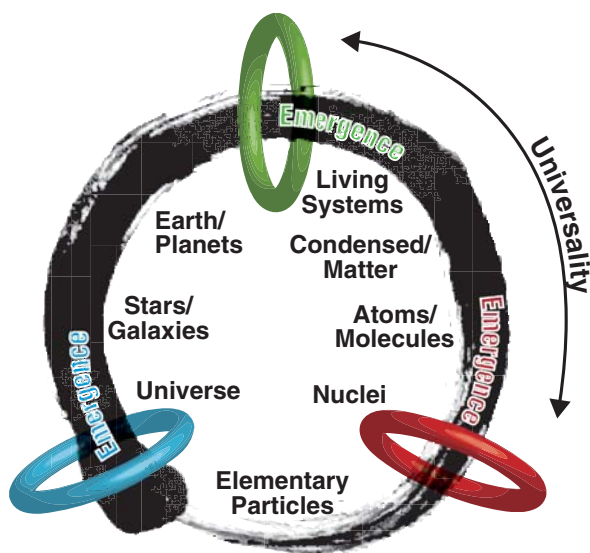
From this viewpoint, it is easy to understand why the interplay of universality and emergence is so important in physics. As an illustration of this point, suppose that some emergent phenomenon on a particular scale happens to be discovered. Then, through the elucidation of the mechanism responsible for this phenomenon, it may be possible to recognize how similar phenomena could occur in other systems and on different scales. This process of discovery, elucidation and induction may thus lead to the prediction of other emergent phenomena. If such novel emergent phenomena are indeed found to exist, then the mechanism responsible for their emergence will be recognized as a universal law. Next, because the same



Program Leader:
Prof. Hikaru KAWAI

procedure should also be applicable to phenomena on more microscopic scales, the pursuit of emergence can, in turn, lead to the discovery of more fundamental laws of physics.

The Global COE program at Kyoto University employs a scientific approach based on the understanding that physics consists, in essence, of the interplay between universality and emergence. Using this approach, our goal is to construct the next generation of physics. In order to achieve our objective, it is essential that we do not view physics as merely a set of sub-fields to be studied independently. Rather, we must take a broad view of physics as a unified field, employing a wider perspective of natural science. For this reason, our program is managed by members whose fields cover all areas in the Division of Physics and Astronomy at Kyoto University. The aim of our program is to advance this view so that it can serve as a stronger base for the study of science – playing a vital role in the development of the next generation of physics – and serve as an international center for fostering talented young researchers capable of opening up new scientific frontiers.



Fostering Top Leaders in Mathematics – Broadening the Core and Exploring New Ground

Mathematics provides the conceptual foundation of, as well as powerful applications in, various fields of science and technology. Therefore the teaching of, and research into, mathematics is essential for Japan's further development. The running bodies of our GCOE project are the Department of Mathematics and Research Institute for Mathematical Sciences of Kyoto University, both of which rank among the leading institutions of mathematics in the world. Capitalizing on this advantage, our GCOE project plans to address the following two points:

(1) Mathematical research in Japan is currently among the best in the world, but it has been noted that the number of young researchers has begun to thin out. We aim to foster world leaders in mathematics for the next generation.

(2) At the same time, in our high-tech world there is an increasing need for mathematically accomplished professionals. We aim to supply society (including academic fields outside mathematics) with individuals with high mathematical expertise.

Our GCOE project consists of three parts, which will cooperate closely with each other to achieve the objectives.

(1) Fostering Top Leaders in Mathematical Research.

Mathematicians tend to show their talent when they are young. Hence it

is extremely important to give them opportunities to establish themselves in the early stages of their career.

(i) We offer positions (from postdoctoral to tenure-track levels) to outstanding young researchers who are to be the mathematical leaders of the next generation. We provide them with a research environment with freedom and stability.

(ii) We promote international exchange at the graduate and post-doctoral levels by sending young researchers overseas, and by accepting international graduate students at our institutions, so that they can build an international research network.

(iii) We enable Ph.D. students to be actively involved in teaching and research as Teaching Assistants and Research Assistants. This also provides them with a financial base during their study.

(iv) We run short-term intensive courses for undergraduate students in order to motivate them to pursue a Ph.D. in mathematics.

(2) Training Graduate Students for Work in Various Fields.

Experts in mathematics can contribute to various fields in academia, industry, and society. This is, however, not always fully recognized by industry and society in Japan.

An advisory board of company executives and researchers are appointed

from the banking, insurance, construction, information technology, bioscience, and economics sectors. Lectures and seminars will be given by experts in those fields in order to train graduate students to become mathematically skilled professionals, capable of working in a range of industries and research institutes. Our



Program Leader:
Prof. Kenji FUKAYA

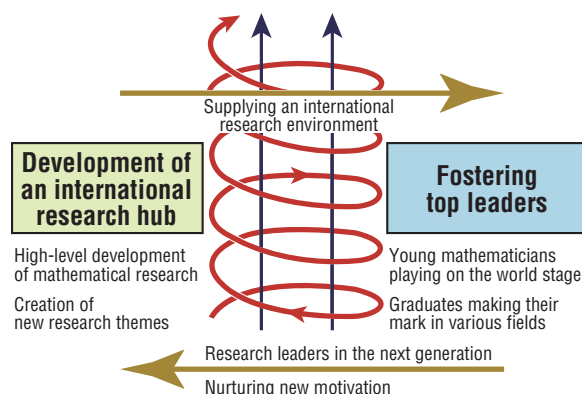
programs include:

(i) Ph.D. level insurance mathematics; (ii) Cooperation between the Kyoto University Institute of Economic Research and the Natural Sciences Research Institute (RIKEN) to pursue new dialogue between mathematics and other disciplines; (iii) A program to enhance the teaching skills of young mathematicians, who are likely to teach math courses when hired for academic positions in the future; (iv) A program to foster excellence among junior and senior high school teachers; (v) Teaching mathematics using computers.

(3) Development of an International Mathematics Research Center.

In order to further enhance our mathematical research, the activities of our GCOE project are being carried out by four research groups focusing on the following areas:

[G1] Integration of number theory and algebraic geometry; [G2] Global symmetry with infinitely many degrees of freedom; [G3] Mathematical analysis of complex phenomena; [G4] Applied mathematics of computation and optimization.



Reconstruction of the Intimate and Public Spheres in 21st Century Asia

Put simply, the 'intimate sphere' refers to the realm of people who are bound together in special relationships of love and care. The concept has been used often by social scientists in recent years. Since the 1970s many regions of the world have seen their family units transformed and diversified, with an increasing number of people opting for life-styles which do not fit neatly into the traditional family mold. The concept of the 'intimate sphere' was put forward as an alternative means to express the realm of private lives in its most basic form.

The opposite of the 'intimate sphere' is the public sphere, but in the present age the boundary between the intimate and public spheres is sometimes fluid, and is characterized by the profound influence the two spheres exert on each other, and the way both of them are continually being transformed. 'Global householding', where a family member goes to live abroad for

work, education or marriage, or where a foreigner comes to live with a family as a domestic or care worker, is no longer rare. Frequent human migration resulting from globalization demands a fundamental reassessment of the frameworks for sending and receiving countries, which includes their welfare and citizenship.

Our objectives at GCOE are to clarify the mechanisms of this 'reconstruction of the intimate and public spheres' which is developing on a global scale, to predict the future directions the changes will take, and to make proposals for improvement. To these ends, we need inter-disciplinary collaboration between social science and its allied fields, and a global research partnership, as well as global and interdisciplinary educational practices.

One of our flagship projects at GCOE is the Asian ERASMUS Pilot Project. Research institutes and universities in Asia, Europe and America, at present (February

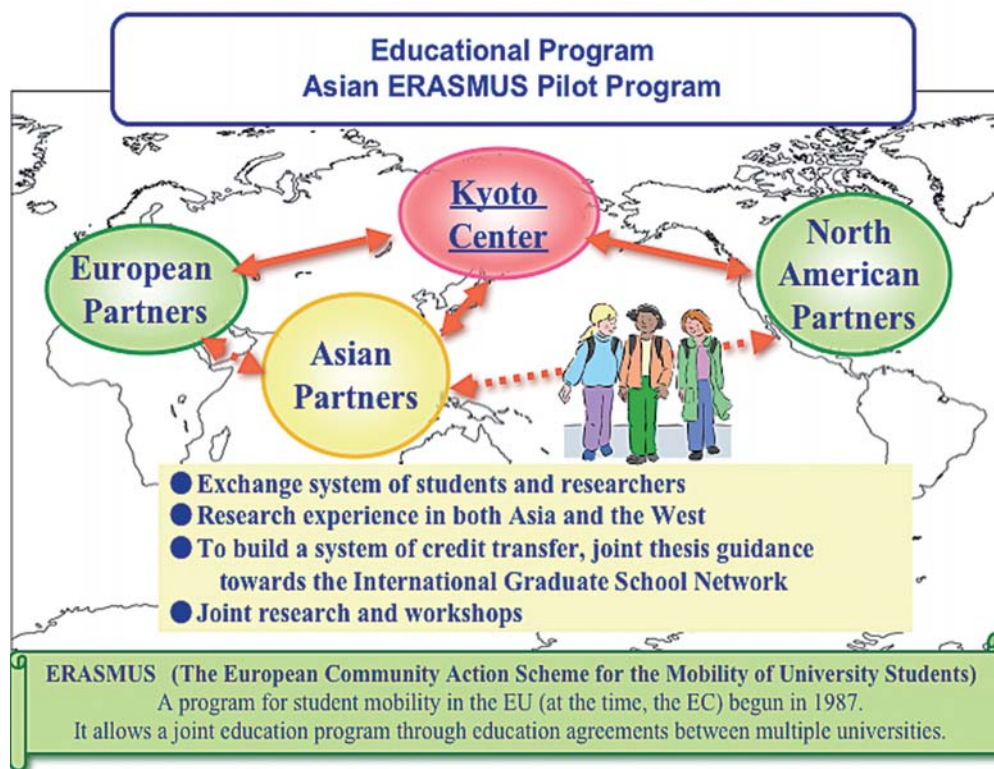


Program Leader:
Prof. Emiko OCHIAI

2009) numbering 13 institutions from 12 regions, have become our Overseas Partner Institutions, and there are frequent exchanges between next generation researchers and of teaching staff. We shall

build a system whereby next generation researchers can gain research experience overseas while doing their doctorate or post-doctoral research, and receive research supervision from both Asian and European or American teachers, either in Kyoto or at a partner center overseas.

We are experimenting with this venture as an Asian version of the EU's ERASMUS (European Region Action Scheme for the Mobility of University Students) Project. We are confident that, starting with this effort, we can forge an intellectual common base, first in Asia and then globally; we can nurture an alumni network across national borders, and develop numerous highly productive international joint research projects.



Energy Science in the Age of Global Warming – Toward a CO₂ Zero-emissions Energy System –

Securing energy and conservation of the environment are the most important issues for the sustainable development of human beings. Until now, people have relied heavily on fossil fuels for their energy requirements and have released large amounts of CO₂. Greenhouse gases such as CO₂ have been regarded as the main factor in climate change in recent years, as stated in the IPCC report in 2007. The energy problem cannot be simply labeled as a technological one, as it is also deeply involved with social and economic elements.

The Graduate School of Energy Science, the Institute of Advanced Energy, Department of Nuclear Engineering, and the Research Reactor Institute have jointly proposed a Global COE program to establish an international education and research platform to foster educators, researchers, and policy makers who can develop technologies and propose policies for establishing a scenario toward a CO₂ zero-emissions society no longer dependent on fossil fuels, by the year 2100. At the Global COE, students will acquire the faculty to survey the whole “energy system” through participation in scenario planning and interaction with researchers from other fields, and apply it to their own research. This approach is expected to become a major feature of human resources cultivation.

In the course of implementing the Global COE, we placed the GCOE Unit for Energy Science Education at the center, and we proceed from the Scenario Planning Group, the Advanced Research Cluster to the Evaluation, forming mutual associations as we progress.

The Scenario Planning Group sets out scenarios for the transition from current energy systems to a CO₂ zero-emissions energy system, establishes new methods of forecasting possible technology for CO₂ reduction, and proposes new social values for a CO₂ zero-emissions society, by integrating the social sciences, human sciences and natural sciences to realize sustainable energy systems.

The Advanced Research Cluster promotes the socio-economic study of energy, study of new technologies for solar energy and biomass energy, and research for advanced nuclear energy by following the road map established by the Scenario Planning Group.

Evaluation is conducted by exchanging ideas among advisors inside and outside of the university and from abroad, to gather feedback on the scenario, education, and research.

For education, which is the central activity of the Global COE, we establish the GCOE Unit for Energy Science Education and select 30 students annually from the doctoral course, and foster these human



Program Leader:
Prof. Takeshi YAO

resources. Students of the Unit participate in the Scenario Planning Group and the Advanced Research Cluster. The students also attend international internships and research workshops outside Japan. We will strive to foster young researchers who will not only be able to employ their skills and knowledge with a wide international perspective as well as expertise in their field of study in order to respond to the needs of the society in terms of the variety of energy and environmental problems, but who will also lead people to a 21st century full of vitality and creativity, working towards harmony between the environment and mankind.

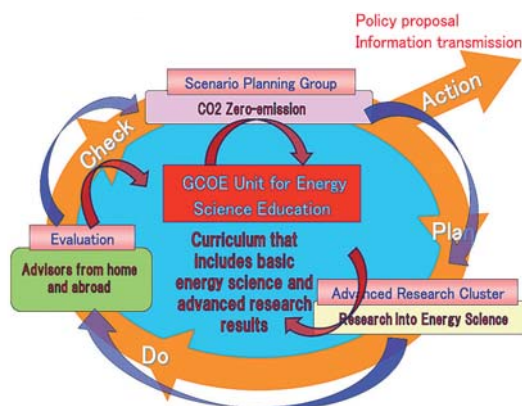


Figure 1. Organization of the Global COE

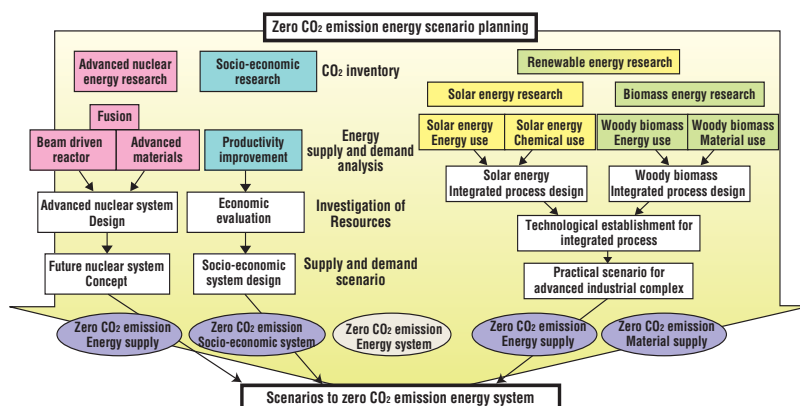


Figure 2. Outline of the Research Tasks

The 12th Kyoto University International Symposium

The 12th Kyoto University International Symposium (KUIS-12): “Transforming Racial Images: Analyses of Representations” was held at the Kyoto University Clock Tower Centennial Hall on December 5 to 6, 2008. Since the year 2000, Kyoto University has held one or two international symposia annually in selected venues around the world in order to promote its academic activities, particularly in those fields in which the university excels. This 12th symposium was supported by the Kyoto University Foundation and the Science Council of Japan. The two-day seminar was attended by approximately 430 participants. Despite very bad weather conditions in Kyoto during the symposium, the event saw active participation by many researchers and students from Kyoto University and other institutions, as well as many participants from outside the academic world.

The symposium began in the afternoon of the 5th with welcome addresses from Kyoto University president, Dr. Hiroshi Matsumoto and director of the Institute for Research in Humanities, Prof. Bunkyo Kin. The proceedings were chaired by Prof. Shigeki Iwai of the Institute for Research in Humanities. Following those introductory speeches, Prof. Yasuko Takezawa of the Institute for Research in Humanities, chairperson of the symposium’s organizing committee gave an overview of the aims of the symposium. Prof. Takezawa explained that the symposium aimed to explore the sense of reality that is produced through racial representations, and how those representations continue and transform. Prof. Takezawa expressed her hope that through Kyoto University’s unique interaction between the humanities and sciences, the

symposium would provide its participants with new modes of thinking – different from those commonly held in the United States and Europe – about what has been conventionally regarded as “different.”

Following Prof. Takezawa’s address, Prof. Ella Shohat of New York University delivered a keynote speech entitled “Stereotype, Representation and the Question of the Real: Some Methodological Proposals.” Prof. Shohat’s speech was followed by further presentations by researchers from Kyoto University and other institutions, and a “Talk Relay” in which several Kyoto University junior researchers gave presentations about their research. Following the presentations, a poster session was held, giving the audience a chance to speak with the junior researchers about their work.



Prof. Ella Shohat

In the evening of the 5th, a reception was held in the Clock Tower International Conference Hall. The reception began with a greeting by President Hiroshi Matsumoto, which was followed by a toast by Prof. Bunkyo Kin. Following those welcoming addresses, the atmosphere became more relaxed with a performance of Venezuelan folk music by Ensemble Cellerste, who were joined for their performance by symposium presenter Associate Prof. Jun Ishibashi of the Graduate School of Arts and Sciences

of the University of Tokyo. Several of the reception’s participants were enticed to dance by the music’s infectious Latin rhythms.

The second day of the symposium began with an opening address by Prof. Toshio Yokoyama, director-general of Kyoto University’s Organization for the Promotion of International Relations. In his speech, Prof. Yokoyama explained Kyoto University’s academic style to the symposium’s guests from overseas, describing its emphasis of fieldwork and keen awareness of language when presenting new discoveries. Following Prof. Yokoyama’s opening address, seven researchers from Kyoto University and other institutions gave presentations, including Dr. Margaret Sleeboom-Faulkner of the University of Sussex, Dr. Marvin Sterling of Indiana University, and Prof. Troy Duster of the University of California, Berkeley and New York University, who gave a keynote lecture entitled “Human Genetics and Human Taxonomies: Fluidity, Continuity and Transformations.” Following the presentations, a discussion session was held, chaired by Associate Prof. Akio Tanabe of the Institute for Research in Humanities. The panel for the session included many of the symposium’s presenters and chairpersons, as well as Prof. Fumihiko Matsuda of Kyoto University’s Graduate School of Medicine, who is involved in international statistical analysis of the minute differences among human genomes. The panelists responded to many questions from the audience, and the active discussion session considerably exceeded its allotted time. Following the discussion session, an after-party was held in the Clock Tower Centennial Hall Lounge, where the presenters had an opportunity to relax and mingle with the audience and the other symposium participants.

On the 7th, a post-symposium conference was held at the Institute for Research in Humanities. The conference gave 20 invited specialists, including several of the symposium’s guest speakers from overseas the chance to further discuss the issues raised at the seminar, making the most of the valuable opportunity for constructive academic exchange.



President Matsumoto, Prof. Takezawa and Prof. Yokoyama



Associate Prof. Jun Ishibashi with Ensemble Cellerste

Daily Life, Environment & Peace – Studying in Vietnam

The overseas study program of the international exchange course “Daily Life, Environment & Peace – Studying in Vietnam” was held from September 7 to 22, 2008. The program was run in cooperation with Hue University and supervised by Associate Prof. Ueru Tanaka and Assistant Prof. Kei Mizuno of the Graduate School of Global Environmental Studies. Eighteen first- and second-year students participated in the program.

The participating students had prepared for the program by attending 11 preparatory lectures at Kyoto University. Beginning in Ho Chi Minh City, the program took the students to Hue City, a mountain village on the Laos border, Hoi An Ancient Town, the former north-south border region and the capital city of Hanoi. Traveling through those various regions, the students were able to gain first hand experience of the history, natural environment and daily life of each area. Now in its third year, the program also benefited from the substantial efforts made by the students of Hue University, who had prepared various activities for the visiting students. A reporting and reunion event for the program was held at the Graduate School of Global Environmental Studies

on December 19, 2008.

The event was organized by students who participated in the course from 2006 to 2009, and was attended by approximately 80 participants, including Dr. Hiroshi Matsumoto, president of Kyoto University, Prof. Junichi Mori, director of the International Center as well as staff and students from the Graduate School of Global Environmental Studies and several Vietnamese students studying at Kyoto University. Faculty and students of Hue University in Vietnam also participated through a video conferencing system.

The event included presentation reports by the program participants and a slide show prepared by the Hue University students. The participants also enjoyed Vietnamese cuisine



Students in ao dai (traditional Vietnamese dress) enjoy Vietnamese cuisine at the reporting and reunion event.

and confectionary prepared by the students as a cheerful party was conducted via the video conferencing screen. A commemorative booklet containing tour reports and messages from the students and staff of both Kyoto University and Hue University was also prepared, highlighting the significance of the two-week program for each student as well as the significance of the exchange between the two universities.



Students from Kyoto University and Hue University visit a world heritage site.

Thai Students Experience Kyoto

As part of an international exchange course between Kyoto University and Kasetsart University in Thailand, eight students and two faculty members from Kasetsart University visited Japan for ten days from October 14 to 24, 2008. In August 2008, fourteen students from Kyoto University visited Thailand as part of the same course. The Kyoto University students were glad to have the opportunity to return the hospitality shown to them during their trip, acting as hosts for the Thai students as they attended classes and participated in various excursions and activities.

In addition to attending lectures at Kyoto University, the Thai students learned about Kyoto and its surrounding areas on a

field-trip to Nara, accompanied by a professor who is a first-class registered architect, and on an overnight study-trip to Maizuru City and Ashiu Village organized by the Graduate School of Agriculture. The visit by the Thai students served to deepen the strong relationship between Kasetsart University and Kyoto University.



The visiting students try on Japanese kimonos.



The field-trip to Nara.



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P R O M E N A D E

京都逍遙

角屋

Sumiya — a place where the entertainment and banqueting culture of the Edo Period emerged

Follow the elevated tracks 300 meters south from Tanbaguchi station on the JR Sagano Line. When you get to a residential district, you will notice 'The Sumiya museum of hospitality culture' etched into the lattice and the red wall (which was regarded as a high class wall in the Edo period) and its designation as an important National Cultural Treasure. Sumiya is the only surviving masterpiece of the architectural style of *ageya** in Japan. It is a two story *ageya* made of wood, featuring a tea house in a spacious garden facing the main Japanese style sitting room, and a huge open kitchen.

An *ageya* is something like what we would nowadays call a *ryotei* (high class Japanese-style restaurant), a place where banquets with music and dancing were held, accompanied by *geisha* and *taiyu* (premiere *geisha*) being summoned from the nearby *okiya**. It was also at the same time a cultural space where important guests were entertained with tea ceremonies and haiku poetry readings. On the *fusuma*, the sliding doors of the guest sitting room there are hand-drawn paintings by some of the greatest artists of the Mid-Edo Period, such as Buson Yosa and Okyo Maruyama. We can still feel the atmosphere of that place even today.

In the autumn of the year before last, Prof. Kazuo Oike, then President of Kyoto University, was invited to a haiku reading held at Sumiya. He noticed that the trains ran very close by the building, and the vibrations caused by the trains led him to consider the possible effect that an earthquake might have on the building. This led to the university setting up a survey group, out of their own funds, with Prof. Kohei Komatsu of the Research Institute for Sustainable Humanosphere as its leader. They installed micro-vibration recorders at nine locations in total to gauge the vibrational characteristics of the building, and investigated the effect on the building that an earthquake in the same class as the Southern Hyogo Earthquake (1995) would have. They collected data for calculating the stress bearing capability of the building by carrying out detailed checks of the relational positions of the pillars and beams and the number of walls.

The survey group held a symposium this spring based around these findings. One can see from this how Kyoto University is actively contributing to the preservation of important cultural treasures in the city.

*an *ageya* (Ageru=inviting in, Ya=building) is a two story building where guests were escorted to the main sitting room on the second floor.

*an *okiya* is a business which dispatches *geisha* and *taiyu*.



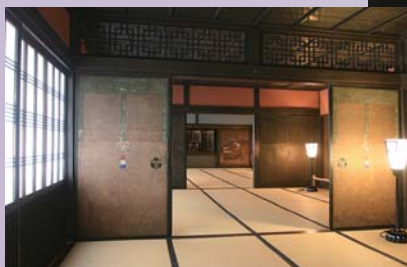
Prof. Kohei Komatsu, who headed the survey (right), and Munekazu Minami, a doctoral student of Kyoto University, and firstclass architect and building engineer (left).



The kitchen, which is almost the size of a temple kitchen. At the back, one can see Sumiya's *noren* curtains. They depict the family crest.



Looking at the main garden, called the Pine Garden, from the Pine Room, the large sitting room on the first story. There is a crisp contrast between the green of the pine and the white of the sand.



Going up to the second floor, one can see right through to the Fan Room at the other end of the house.



In the Fan Room at the south corner of the second floor, the 59 fans pasted up on the ceiling depict Chinese and Japanese paintings and calligraphic works, and on the *fusuma* doors there is a picture of scenes from *The Tale of Genji*, the oldest novel in Japan.